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Effect of Relative Humidity on the Flashover Strength of Solid Insulation

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Surface flashover across solid dielectric/gas interfaces is a problem that can occur during operation of gas-insulated high voltage (HV) equipment. The present work is aimed at investigation of the surface flashover characteristics of different solid dielectrics and surface topologies, stressed with HV impulses in air at different pressures. An experimental system has been developed to control the relative humidity (RH) of air, to determine the effect on the flashover strength of solids under different combinations of these test conditions. Samples of Delrin (Polyoxymethylene), HDPE (High-Density Polyethylene) and Ultem (Polyetherimide) have been tested between parallel-plane electrodes.

The solid samples were cylindrical, with their surfaces machined to a smooth finish. Samples with a modified, 'knurled', surface finish were also tested after a specific cleaning method was performed on all samples. Both positive and negative polarity impulse voltages were applied across the electrodes using a 10-stage Marx generator, configured to produce a 100/700 ns output voltage waveform, with a peak voltage up to 200 kV. Solid samples were tested in air with low (<10%) RH, and in air pre-treated with an ultrasonic humidifier to achieve medium (~50%) and high (>90%) RH. Tests were undertaken at -0.5, 0 and 0.5 bar gauge.

Each solid sample was characterised in terms of average flashover voltage and time to breakdown, over 20 individual breakdown events. The voltage was increased in steps of 3 kV from a 'no breakdown' level until a flashover event occurred, and the process was repeated until 20 flashover data points were recorded per test condition. Two withstand levels were observed before a valid breakdown voltage was recorded, in accordance with the ASTM D3426-97 standard. The results will inform on the flashover performance of the different materials, and on the relative reduction in the breakdown strength of solid/gas interfaces in sub-optimal conditions.

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